Supplemental Material

Distributed Lag Analyses of Daily Hospital Admissions and Source-Apportioned Fine Particle Air Pollution

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Positive Matrix Factorization (PMF-2) Source Apportionment Model & Results

A description of the source apportionment model using chemical speciation data collected at the NYU monitoring site (Supplemental Material Figure 1) and results from this analysis, including a detailed description of the PM sources in New York City, are provided here.

Methods: PMF-2 Source Apportionment model

Positive Matrix Factorization (PMF-2) was used to conduct the source apportionment analysis of the $PM_{2.5}$ mass into daily source-specific contributions. This PMF-2 technique was developed by Paatero and Tapper and has been widely applied by numerous air pollution source apportionment studies (Paatero and Tapper 1994, 1997; Song et al, 2001; Ito et al, 2004; Kim et al, 2004). Previously published work describes source apportionment of New York City 2001 data using this same technique (Lall and Thurston, 2006). This technique has some advantages over regular factor analytic models, as it utilizes error estimates of the measured elements (i.e., the uncertainty of measurement associated with each observation is included) in the model, and also includes non-negativity constraints that are more appropriate for environmental data, and thereby assures a physically plausible quantitative model.

Eighteen $PM_{2.5}$ trace element constituents and EC were chosen for inclusion in the PMF-2 source apportionment model. The trace elements were chosen based on the XRF instruments detection limit, percent of observations above detection and the computed signal-to-noise ratio for each element (Lall and Thurston, 2006). A summary of the variables included in the source apportionment model is provided in the Supplemental Material Table 1. A seven-factor PMF-2 solution was resolved and, using a multiple linear regression of total $PM_{2.5}$ mass and daily scores for the seven source categories identified, daily source-related $PM_{2.5}$ mass contributions were estimated.

Results: Description of New York City $PM_{2.5}$ sources resolved using PMF-2

The seven "source" categories identified, include: long-range transported sulfates; traffic; residual oil; steel dust; soil; WTC plume; and, winter-time chlorine peaks. Five of these 7 $PM_{2.5}$ sources were considered *a priori* for subsequent health analyses; the WTC plume and wintertime chlorine were excluded from the health analysis, as these were rare events with isolated spikes. A summary of each of the five sources considered in the health analyses is provided here.

Long-range transport sulfate component (correlated highly with sulfur and selenium) was found to explain the largest portion (almost 50%) of the total $PM_{2.5}$ mass, and was associated with a strong seasonal trend (Supplemental Material Figure 2). The traffic related PM was strongly correlated with EC, iron, calcium and barium, which suggests a mix of emissions exhaust, re-suspended road dust and tire/brake wear. A strong day-of-week pattern was also observed for this source, with weekday concentrations higher than weekend concentrations, as expected. The residual oil-burning source was highly correlated with nickel and vanadium, known tracers of this source (Cooper and Watson, 1980; Spengler and Thurston, 1983) and SO_2 gas concentrations in the city. This source was found to be much higher during winter (i.e., months associated with heating) than summer months. The "steel" category, correlated with manganese and iron, was found to be elevated during the months following September 11th, most likely as a result of construction and welding activities at Ground Zero, but it could possibly also include other local construction activities (e.g., observations in July-August 2001). A similar WTC "Fe-Mn" or "steel" source was also identified in a study of WTC exposures using data collected during September-December 2001 at the NYU Downtown Hospital located a few blocks from the WTC site (Thurston et al, 2003). The soil category was highly correlated with crustal elements, silica, calcium and iron. This “natural” soil source was found to be especially elevated during the summer of 2002, a period of drought in most of the eastern parts of the U.S. (NOAA, 2003).

References

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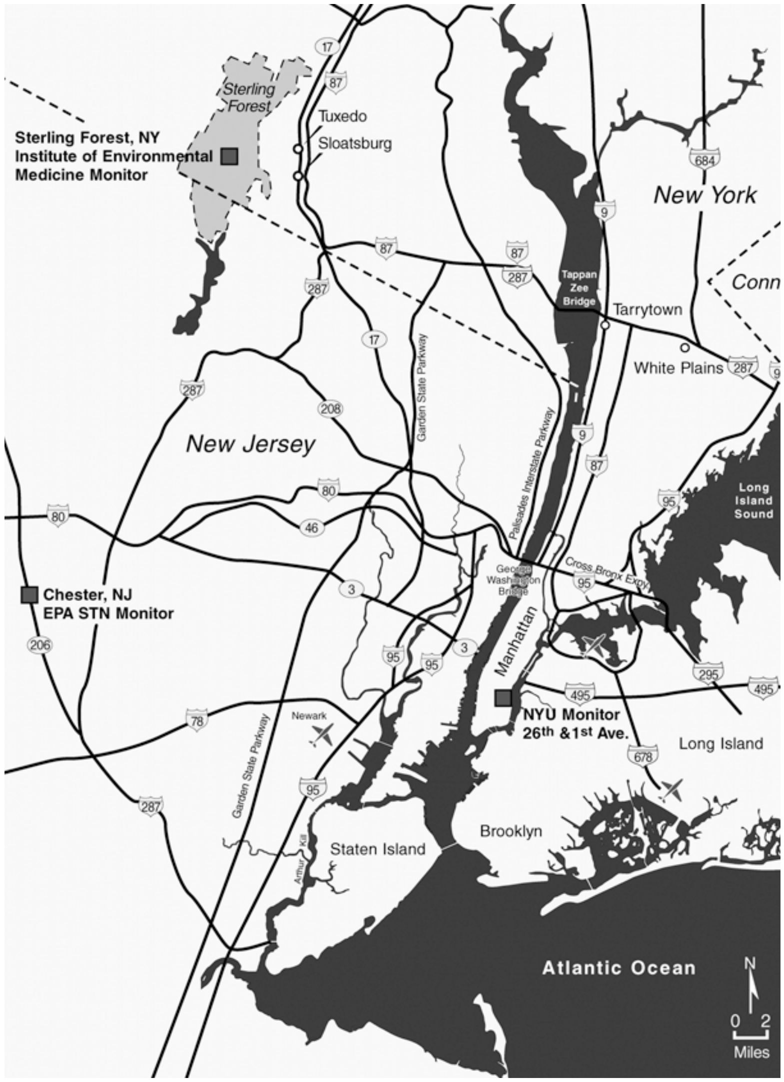
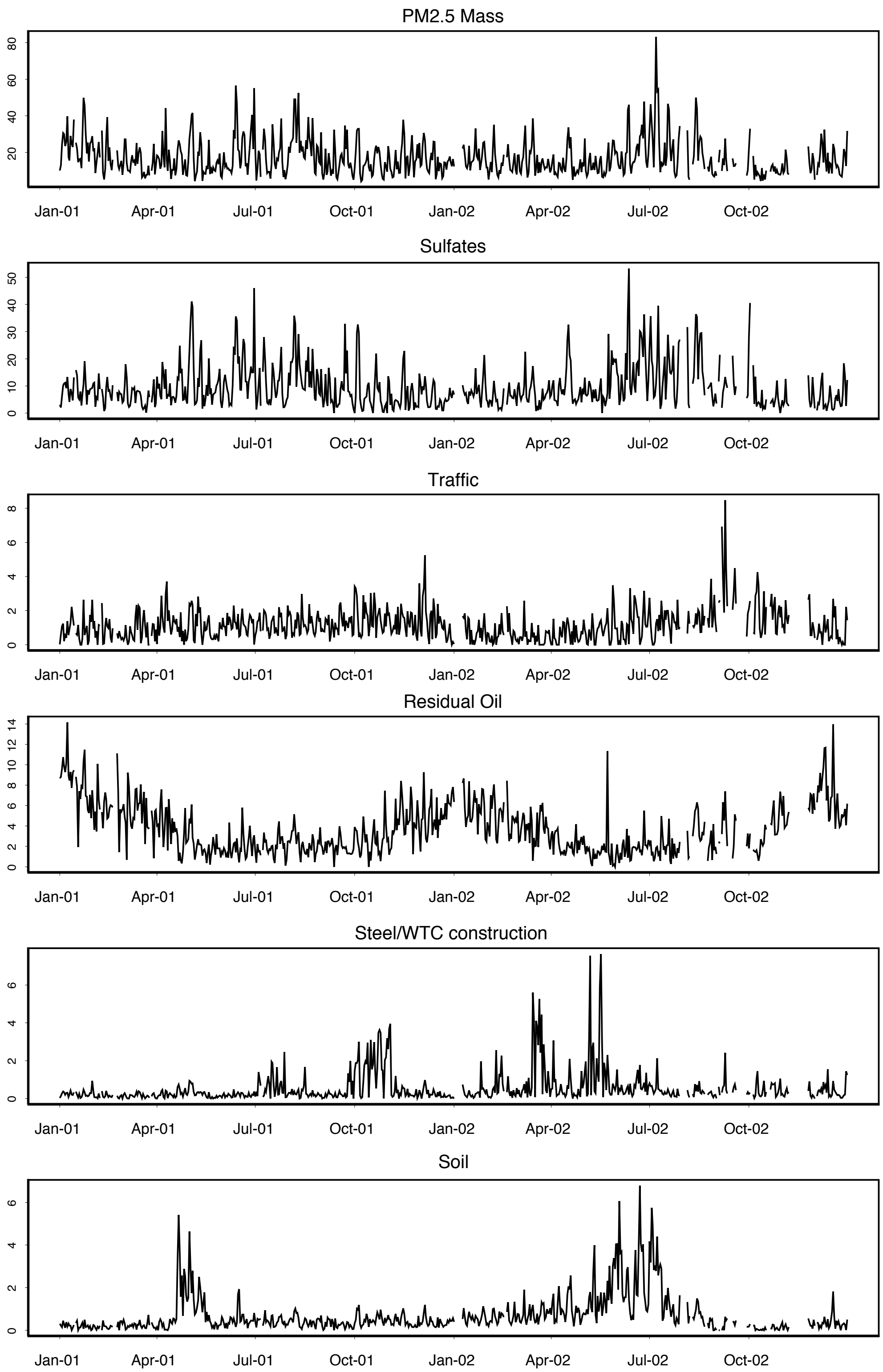
Supplemental Material, Table 1. Summary (Mean ± Standard Deviation) of $PM_{2.5}$ and $PM_{2.5}$ constituents included in PMF-2 source apportionment analysis.

$PM_{2.5}$ Constituents	Mean ± Std. Dev (ng/m^3)
$PM_{2.5}$	17261 ± 9794
Mg	27 ± 24
Al	51 ± 90
Si	183 ± 202
S	1659 ± 1385
Cl	42 ± 194
K	56 ± 57
Ca	75 ± 64
V	10 ± 6
Mn	8 ± 12
Fe	229 ± 161
Ni	26 ± 25
Cu	7 ± 10
Zn	45 ± 67
Se	4 ± 2
Br	7 ± 22
Ba	12 ± 8
Pb	8 ± 23
EC	1229 ± 603



Supplemental Material, Figure 1. Location of NYU $PM_{2.5}$ monitoring site in Manhattan, New York City



Supplemental Material, Figure 2. Time-series plots of $PM_{2.5}$ and source-related PM for NYC (2001-02).